CLAIMS

1. A method of cooling a feed liquid comprising forming at least one sheet of flowing particles of the feed liquid and directing cryogen at the particles from both sides of the sheet.

2. A method according to claim 1, wherein the sheet of flowing particles is formed by atomising the feed liquid.

3. A method according to claim 2, wherein the feed liquid is atomised by a compressed gas.

4. A method according to any one of the preceding claims, wherein the said sheet is essentially planar.

5. A method according to any one of claims 1 to 3, wherein the said sheet is curved.

6. A method according to any one of the preceding claims, wherein the cryogen is a liquefied gas.

7. A method according to claim 6, wherein the liquefied gas is liquid nitrogen.

8. A method according to any one of the preceding claims, wherein the feed liquid is atomised with a compressed gas which is formed of vapour evolved by the liquefied gas in cooling the particles.

9. A method according to any one of the preceding claims, wherein the particles are solidified by contact with the cryogen.

10. A method according to any one of the preceding claims, wherein the particles of the feed liquid have an average size less than 50µm.

11. A method according to claim 10, wherein the particles are cooled by the cryogen at a rate of at least 1000 K/s.

12. A method according to any one of the preceding claims, wherein the feed liquid is an edible substance.

13. A method according to claim 12, wherein the feed liquid is a molten fat or oil.

14. Apparatus for cooling a feed liquid, comprising at least one nozzle for forming at least one sheet of flowing particles of the feed liquid, at least one first cryogen discharge member having a plurality of cryogen discharge orifices arranged for directing cryogen at one side of the sheet, and at least one second cryogen discharge member having a plurality of cryogen discharge orifices arranged for directing cryogen at the other side of the sheet.

15. Apparatus according to claim 14, in which the nozzle points vertically downwards.

16. Apparatus according to claim 15, wherein the nozzle has an inlet for atomising gas.

17. Apparatus according to any one of claims 14 to 16, wherein the nozzle has a rectilinear elongate outlet.

18. Apparatus according to any one of claims 14 to 17, wherein there is a plurality of nozzles arranged in one or more straight lines.

19. Apparatus according to claim 18, wherein at least some of the straight lines are parallel to one another.

20. Apparatus according to claim 18 or claim 19, wherein at least some of the straight lines essentially define a geometric figure selected from a triangle, a square, a rectangle, and a polygon.

21. Apparatus according to any one of claims 14 to 16, wherein the said nozzle has a curved elongate outlet.

22. Apparatus according to any one of claims 15, 16 and 21, wherein there is a plurality of nozzles which are arranged circumferentially.

23. Apparatus according to any one of claims 18 to 20 and 22, wherein the orifices of the first and second cryogen discharge members are disposed in geometric configurations complementary to that or those of the nozzles.

24. Apparatus according to any one of claims 14 to 23, wherein the orifices of the first and second discharge members are disposed such that in use they are all equidistant from the said sheet of particles.

25. Apparatus according to claim 18, wherein the nozzles are disposed in the upper region of a single generally cuboidal chamber.

26. Apparatus according to claim 18, wherein the nozzles are disposed in the upper regions of a plurality of contiguous generally cuboidal chambers.

27. Apparatus according to claim 26, wherein the chambers are open to one another through their common sides.

28. Apparatus according to any one of claims 14 to 27, wherein the first and second cryogen discharge members are both spray headers.

29. Apparatus according to any of claims 14 to 28, wherein the said orifices are orientated so as, in use, to direct cryogen at the said sheet near to its source.

30. Apparatus according to any one of claims 14 to 29, in which the or each nozzle and the cryogen discharge members are housed in a chamber having an outlet for the cooled particles and the same or a different.

31. Apparatus according to claim 30, additionally including a sensor for sensing the temperature of the spent cryogen, the sensor being operatively associated with at least one flow control valve for controlling the flow of cryogen to the cryogen discharge members.

32. Apparatus according to claim 30 or claim 31, additionally including a cyclone for disengaging fine particles from the spent cryogen.

33. Apparatus according to claim 32, additionally including a compressor having an inlet communicating with the cyclone and an outlet communicating with a pipeline for feeding atomising gas to the atomising nozzle.

34. Apparatus according to claim 33, wherein the chamber has a further outlet for spent cryogen, the further outlet communicating with a baghouse for disengaging fine particles from the spent cryogen.